

FY 2008 Project Proposal

Project No. THOM-08

Protective covers for aircraft, land vehicles and ground structures

Project Team:

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Objective:

A reasonable and logical device for protection of exterior aircraft or other vulnerable surfaces from ice formation, wind, blowing sand or falling hailstones is a cover, designed from a combination of appropriate polymer materials. A very novel approach for such a cover could consist of an individual inflatable/deflatable blanket system of a design, configuration and size to completely cover exposed surfaces of a flight vehicle, ground vehicle or ground structure. Our purpose in the research proposed herein is to determine and test a basic design to most effectively perform these and other requirements such as light weight and low storage volume to stow the material in an aircraft or ground vehicle. We also propose to design the optimized device for easy deployment and adjustment when placing it over the vehicle or ground unit.

State of the Art:

The exterior and interior of an aircraft are constructed with materials that are very susceptible to deterioration and damage (Figure 1.) from various environmental elements such as (1) sun, (2) heat, (3) thunderstorms, (4) hail, (5) rain & fuel contamination, (6) bird and animal nesting and droppings, (7) freezing rain, (8) frost, (9) ice, (10) snow, and (11) extreme cold.

At the present time there does not appear to be any concept, product, application or process that completely or effectively addresses the eleven safety and environmental hazards that expose the aircraft, pilots and or passengers to costly damage and serious injury and possible death as a result of the damage imposed.

There are vendors who sell canvas covers that lay over the windows and are attached to the outside of smaller aircraft in an attempt to restrict the sun from entering the cockpit. This application appears to be marginally effective at best. There are also vendors who sell custom fit reflective materials that are installed in the inside window openings of an aircraft. This reflective material must be cut to the exact size of the window, and then, from the inside, one must press the specific sized reflective material for that particular window opening into the area around the window on the inside of the aircraft. This method is used with smaller aircraft. Since the reflective material is on the inside of the Plexiglas window, a great deal of heat builds up between the actual reflective material and the inside of the window or Plexiglas, causing great stress to the window or Plexiglas and reducing its life.



Figure 1. A typical private aircraft

Proposed solution design:

The bottom layer of the protective cover may be inflatable/deflatable with a layer of soft material suitable to protect an aircraft or other damage prone surface.

The inner layer or layers of the cover could be designed so they have numerous individual air or fiber filled pockets within the structure as shock absorbing and/or temperature insulating layers.

The number of rows and layers within will be determined to protect an aircraft, vehicle or structure from damage from hail and other foreign objects striking it. (Figure 2)

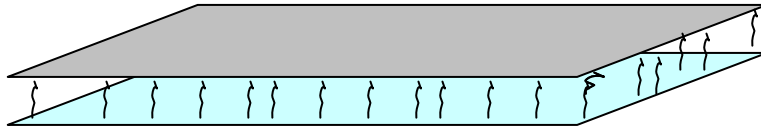


Figure 2. General depiction of multilayer protective cover design

An experimental database already exists at Auburn Polymer and Fiber Engineering to indicate useful designs to protect automobile hoods from hail damage, so an approximate menu of polymer types, combinations and thicknesses can form the basis for a new, lighter, aircraft optimized design. One test utilized height and gravitational force to simulate the impact of hail on the windshield and metal automobile surfaces. A hood was aligned so that the applied force was perpendicular. Three different spheres were used to resemble hailstones. A 16 mm diameter steel ball weighing 17 g, a 19.05 mm diameter glass marble weighing 16.7 g, and a 76.2 mm diameter red ball weighing 90 g were the free-falling objects. These balls were dropped from a constant height of 5.5626 meters. The balls obtained velocities of 10.447 m/s. As each drop hit the car hood, the affected area was circled and numbered for recording purposes. The second test was conducted using a slingshot, ice cubes, and a chronograph for velocity measurement. The car hood was placed approximately 7.5 m away from the chronograph. Twenty-two tests were done on various combinations of sample materials including tests on just the bare hood. An average velocity of 27.8 m/s was established. The test was assessed as a very good simulation of an actual hail situation, since the average hailstone has a velocity of approximately 27.0 m/s. As each piece of ice hit the hood, the damaged or undamaged area was circled and numbered as done in the freefall test. These results were later studied and compared to results from previous tests to determine the best materials to use for the design of the project.

Approach:

This project will be directed toward the creation of a polymer-fabric based flexible structure designed to protect a) aircraft, b) ground vehicles and c) housing and storage structures in a wide range of naturally challenging or hostile environments from 1) impact damage, 2) thermal damage, and 3) ice loading damage.

The proposed research for this project will be conducted by Auburn University Department of Polymer and Fiber Engineering to evaluate the above end use designs are fourfold.

1) To create three feasible samples of vehicle and structure coverings which can serve to simulate the actual final form and construction of one or more of the devices we propose to offer as solutions to the forenamed problems.

2) To test the samples using standard physical testing methodology for the following characteristics:

a- permeability of

1- air

2- water

b- flexure and recovery

c- temperature and humidity effects

d- tensile characteristics (stress, strain, initial modulus and work to break) of individual component layers and of the conglomerate structure

- e- areal density
 - f- thickness
 - g- tear and puncture resistance
 - h- burst resistance
 - i- UV reflectance and transmission
- 3) To determine feasible methods of forming and consolidating any or all of the proposed final structures and testing the fastening and consolidating points for possible tensile, reflectance and or pneumatic seal failure
- 4) To combine, refine and re-engineer sample designs as necessary to meet individual end use objectives and address shortcomings of current designs

Outreach to Industry and Target Market:

This project will make use of a start-up operation in the aircraft covers industry for input, idea validation and for purchase of materials and/or fabrication of test designs in the proposed project. Further input will be sought from significant aircraft user databases such as commercial aircraft operations and military users including the United States Air Force, Navy, Marines and Army. Numerous bases and installations exist in the Auburn University area, and visits will be both convenient and inexpensive. Travel to the manufacturer/subcontractor's site would be very beneficial to discuss and plan for the correct design and assembly of samples for testing.

New Resources Required:

No new test equipment is anticipated. Some data storage equipment such as an external hard drive or a Macintosh and Windows compatible processor with enhanced data storage is anticipated to ensure safe maintenance of the data for analysis and evaluation.

Other:

A graduate student will be supported to provide testing, data collection and evaluation services in the proposed project. Lab technician costs will be covered to provide access to required testing and design modifications that will be required. Secretarial and accountant costs will be covered to support the necessary reports required for US government sponsored research under the Office of Sponsored Projects at Auburn University.